LIFE CYCLE COSTING OF INDUSTRIALIZED BUILDING SYSTEM AND CONVENTIONAL BUILDING SYSTEM

ALI MOHAMMED ALI NAJI AL-ATTABI

UNIVERSITI TEKNOLOGI MALAYSIA

LIFE CYCLE COSTING OF INDUSTRIALIZED BUILDING SYSTEM AND CONVENTIONAL BUILDING SYSTEM

ALI MOHAMMED ALI NAJI AL-ATTABI

A project report submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Science (Construction Management)

Faculty of Civil Engineering
Universiti Teknologi Malaysia

JUNE 2014

To my beloved family

ACKNOWLEDGEMENT

I would like to express my deepest appreciation to all those who provided me the possibility to complete this project report. I would like to express my special appreciation and my thanks to my supervisor, Assoc. Prof Dr. Abdul Kadir Marsono. You have been a tremendous advisor for me. I would like to thank you for encouraging my research and your endless support, which is priceless.

I would also like to thank my beloved wife for her continued support and encouragement during this long march. Your support is very appreciated.

Finally, my sincere appreciation extends to all my friends for their help and advice.

ABSTRACT

Life cycle costing (LCC) is the process of identifying and documenting the initial cost and future cost of the project throughout the lifetime of the building. It is important in determining the design alternatives through analyzing the total cost of ownership over the life span of an asset. Lack of adaptation of the residents with the house design leads them to adjust the house to fit their needs. The aim of this study is to calculate the life cycle costing of the new project as well as the changes and modifications throughout assumed lifespan of two generations for conventional and industrialized building system houses. Furthermore, it also introduces an alternative design to suit the householder needs. To achieve the aims, a research questionnaire survey was distributed among householders to obtain the money spent on housing and the modifications that occurred in the house throughout their home occupation. Moreover, the Net Present Value (NPV) method was adopted to achieve the IBS life cycle costing. Besides, Auto CAD software use to draw different house layouts to fit the residents' requirements obtained from the questionnaire. However, the results showed that the modifications cost of a conventional house equal to 57% of house selling price and the LCC of the conventional building system equal to 67% of the IBS. The research shows that the IBS is a better method of construction as an alternative to a conventional building system.

ABSTRAK

Kos Kitaran Hayat (LCC) adalah proses mengenal pasti dan mendokumenkan kos permulaan dan kos masa depan projek itu sepanjang hayat bangunan. Penenentuan alternatif reka bentuk melalui analisis jumlah kos pemilikan ke atas jangka hayat aset adalah penting. Kurangnya adaptasi daripada kemahuan penduduk kepada reka bentuk rumah menyebabkan mereka mengubahsuai rumah bagi memenuhi keperluan mereka. Tujuan kajian ini adalah untuk mengira kos kitaran hayat projek baru serta perubahan dan pengubahsuaian di sepanjang jangka hayat andaian bagi dua generasi sistem pembinaan konvensional dan perindustrian. Ia juga memperkenalkan reka bentuk alternatif untuk memenuhi keperluan isi rumah. Untuk mencapai matlamat, satu tinjauan telah dijalankan dengan mengedarkan soal selidik dalam kalangan pemilik rumah untuk mengetahui kos dibelanjakan untuk rumah dan pengubahsuaian yang berlaku dalam rumah sepanjang menduduki rumah mereka. Selain itu, Nilai Kini Bersih (NPV) telah diguna pakai untuk mencapai kos kitaran hayat IBS. Selain itu, perisian Autocad digunakan untuk melukis susun atur rumah yang berbeza untuk disesuaikan dengan keperluan penduduk yang diperolehi daripada soal selidik. Walaubagaimanapun, keputusan menunjukkan bahawa kos pengubahsuaian rumah konvensional bersamaan dengan 57% daripada harga jualan rumah dan LCC bagi sistem pembinaan konvensional adalah bersamaan dengan 67% daripada SPI. Kajian menunjukkan bahawa IBS adalah kaedah pembinaan yang lebih baik sebagai alternatif kepada sistem pembinaan konvensional.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

The construction industry is a sector that has a big contributes towards the economic growth in Malaysia. The government of Malaysia recognizes that the housing as a basic human need and an important component of this industry, providing the sustainable and affordable housing to every citizen are part of their aim. The rapid development must meet the current and future needs of the Malaysian citizen to achieve more economic and sustainable house. This has led to the formulation of a variety of policies and approaches aimed to ensure that all Malaysian have access to an adequate housing ownership program.

The need to provide affordable, sustainable, adaptable and functionally competent housing is the fundamental needs of living standards and well being of individuals and families throughout the World. Friedman (Friedman, 2002) defined adaptability for homes as "providing occupants with forms and means that facilitate a fit between their space needs and the constraints of their homes either before or after the occupancy". Therefore, adaptability in general is the ability of individual for modifications to suit new conditions. The ability to adapt to changing needs by

changing internal walls and installation inside a dwelling unit while maintaining a constant activity area may be described as internal variability. Practically, adaptability covers all internal changes, including changes of character in both the availability of space and the structure of space, subdivision, and the combination of spaces. A basic interpretation of adaptability is the refitting of a physical environment as the result of a new circumstance (Rahim, et al, 2012).

The nature and diversity of Malaysian society give a diversity of cultures and customs that may affect the natural needs of the housing layout, for example, by adjusting the house to fit their requirements or expanding the basic layout design. These modifications may occur once or in multiple time during the life cycle of the house according to the need at the necessary funds. The cost of the modifications is an important cost which added to costs incurred by the householder to adapt his house.

Life cycle costing (LCC) is the process of identifying and documenting the initial cost and future cost of the development project during the lifetime of the building (Rum, et al, 2011). Therefore, to estimate the cost of such houses throughout the assumed life span, the life cycle costing analysis is a useful method.

The manner and method of construction contribute in determining the construction cost in addition to the incurred costs during the building life cycle. The conventional building system is the most common construction method in Malaysia. Industrialized building system (IBS) is the new method of construction that improve sustainability, such as reducing construction time, minimizing construction waste, and providing more environmentally friendly conditions during construction operations. Due to the unique characteristics of IBS, it certainly supports the above mentioned perspectives. The world has currently been alarmed with the issue of environment and sustainability, and indeed the construction industry has to be constantly worried by the increasing cost of building maintenance and life cycle issues (Rahim, et al, 2012).

In this research the studying of life cycle costing of two building systems which are the conventional building system and IBS will provide an overview in understanding the hidden costs over the building lifespan.

1.2 Problem Statement

Housing price is the most remarkable thing for people who wish to own a house, especially for those with low income. A study shows that the affordability of housing does not only depend on housing prices but also the household income status. The main concept of the Malaysian house comprises a living and a bedroom, and it expands to the kitchen and so on. When the house grows, it expands and more rooms or spaces need to be added to the needs of the house owner (Yiung, 2013). This occurs because of the house owner need a compatible home that suits his budget. The home expanded to the living requirements and the increase in the number of family members or because of aesthetic reason.

The cost incurred from the design modification, changing of functionality and expansion the house during its life cycle will increase the burden on the householder especially for those with low income salary. Consequently, the cost of building depends on the method of construction, not only in the construction phase, but throughout its life cycle.

In order to mitigate the burden and reduce the cost to conform with the householders' income, it is important to study a house life cycle cost regarding to the modifications chronology. Conventional building system is common in Malaysia and the development of an industrialized building system is progressing towards its wide advantages of durability and affordability.

Studying the life cycle costing of the aforementioned building systems would provide an opportunity for developers to choose the most appropriate construction system within the limits of their customers' income in addition to paying attention to the hidden costs during the building life span.

1.3 Objectives

The aim of this study is to calculate the life cycle cost of an industrialized building system type of housing and conventional building system regarding to the expansion in the dimensions and the possible changes in the space through the following objectives:

i. To calculate the life cycle costing of conventional building system houses that will be utilized to up to two generations.
ii. To study the differences of requirements between the life cycle costing of IBS houses and the conventional building system houses for the occupancy of two generations.
iii. To propose an alternative home layout plan based on the current residents' requirements that suit the current and future needs of the occupants.

1.4 Scope of the Study

This study does a life cycle cost calculation for residential conventional building system and industrialized building system (IBS) in Malaysia. The IBS building system that highlighted in this study is a frame system. The study calculates

the cost of the modification, alteration, changing the role of space and the expansion that may happen in the building due to the user needs for extra space or aesthetic. The period of the study assumes a life span of two generations (60 years) with no change of building ownership. It will also calculate the possible modification to take into account the income of the house owner.

1.5 Significance of the Study

The research gives the real life cycle costing calculation for the residential housing throughout the building life span rather than focusing on the construction cost. The hidden incurring that need to be sustained by the owner of the building arising from the change and expansion in the house plan as a part of their requirements, throughout the life cycle of the buildings.

REFERENCES

Abdullah, M.R, Kamar, K.A.M, Nawi, M.N.M, Haron, T and Arif, (2009), Industrialized Building System: A Definition And Concept. Processing in *ARCOM Conference*, 7-9 September 2009, Nottingham, United Kingdom.

Ashworth, A. (1996). Estimating the life Expectancies of Building Components in Life-Cycle Costing Calculations. *Structural Survey, 14*(2), 4-8.

Baldwin, E., and Tomita, S. (2008). Housing in Response to the Human Life Cycle. *Aging, Disability and Independence*, 1-17.

Bell, P. A., Greene, T. C., Fisher, J. D., and Baum, A. (2001). *Environmental Psychology* (Fifth ed.). Belmont CA: Wadsworth Group.

British Standards Institution, *Building & Constructed Assets Service Life Planning, part 5: Life Cycle Costing*, BS 15686-5, London, 2008.

Çağdaş, G. (1996). *A Shape Grammar Model for Designing Row-Houses.* Design Studies, 17(1): 35-51.

IBS Roadmap (2003-2010). *Construction Industry Development Board* (CIDB). Malaysia.

Dhillon, B. S. (2009), *Life Cycle Costing for Engineers*. Gordon and Breach Science Publishers S.A, Amsterdam.

Dhillon, B. S. (2011). *Life cycle costing for engineers*. Taylor & Francis US.

Fabrycky, W. J., and Blanchard, B. S. (1991). *Life-Cycle Cost and Economic Analysis* (pp. 144-174). Englewood Cliffs, NJ: Prentice Hall.

Flanagan, R., Norman, G., Meadows, J. & Robinson, G. (1989), *Life Cycle Costing Theory and Practice.* Oxford: BSP Professional Books.

Friedman, Avi (2002). *The Adaptable House*. New York: McGraw-Hill.

Fuller, S. (2010). *Life-Cycle Cost Analysis (LCCA).* National Institute of Building Sciences, An Authoritative Source of Innovative Solutions for the Built Environment, 1090.

Hanson, J. (2003). *Decoding Homes and Houses*. Cambridge University Press.

ISO, (2004), ISO/DIS 15686-5 *Buildings and constructed assets-service life planning*, International Organization for Standardization.

Kishk, M., Al-Hajj, A., Pollock, R., Aouad, G., Bakis, N. & Sun, M. (2003) *Whole Life Costing in Construction: A State of the Art Review*. RICS Foundation.

Korpi, E., and Ala-Risku, T. (2008). Life Cycle Costing: A Review of Published Case Studies. *Managerial Auditing Journal*, *23* (3), 240-261.

Lessing, J., Stehn, L., & Ekholm, A. (2005). Industrialized Housing: Definition and Categorization of the Concept. *Proceedings of IGLC-13*.

Moles, P. & Terry, N. (1997). *The Handbook of International Financial Terms*, Oxford University Press.

Norman, G. (1990). Life Cycle Costing. *Property Management*, *8* (4), 344-356.

Omar, E. O. H., Endut, E., & Saruwono, M. (2010). Adapting By Altering: Spatial Modifications of Terraced Houses in the Klang Valley Area. *Asian Journal of Environment-Behaviour Studies*, *1* (3).

Omar, E. O. H., Endut, E., & Saruwono, M. (2012). Before and After: Comparative Analysis of Modified Terrace House. *Procedia-Social and Behavioral Sciences*, *36*, 158-165.

Rahim, A. A., Hamid, Z. A., Zen, I. H., Ismail, Z., & Kamar, K. A. M. (2012). Adaptable Housing of Precast Panel System in Malaysia. *Procedia-Social and Behavioral Sciences*, *50*, 369-382.

Rasoulijavaheri, A. (2013). *The Requirement for Implementation of Open Building System Terrace Houses in Malaysia*. Universiti Teknologi Malaysia, Skudai.

Reis, A. (2003, June). Original and Converted Social Housing: Spatial Configurations and Residents' Attitudes. In *Proceeding, 4th International Space Syntax Symposium London2003, www. spacesyntax. net/sympo sia/SSS4/full papers/40 Reispaper. pdf* (Vol. 24, No. 2012, pp. 13-40).

Rum, M., Azizah, N., & Akasah, Z. A. (2011). Implementing Life Cycle Costing in Malaysia Construction Industry: A Review.

Russell, P. and Moffatt, S. (2001). *Assessing Buildings for Adaptability.* IEA Annex, 31.

Sazally, S. H., Omar, E. O. H., Hamdan, H., & Bajunid, A. F. I. (2012). Personalisation of Terraced Houses in Section 7, Shah Alam, Selangor. *Procedia-Social and Behavioral Sciences*, *49*, 319-327.

Schade, J. (2007). Life Cycle Cost Calculation Models for Buildings. *University of Technology, Lulea Sweden.*

Smullen, J. & Hand, N. (2005). *A Dictionary of Finance and Banking,* Oxford University press.

Stanford university (2005). *Guidelines for Life Cycle Cost Analysis (LCCA).* Land and Buildings.

Woodward, D. G. (1997). Life Cycle Costing—Theory, Information Acquisition and Application. *International Journal of Project Management*, *15*(6), 335-344.

WSDOT (2008). Cost Estimating Manual for WSDOT Projects.

Yiung, S.W. (2013). *Open Building System Towards Functional Sustainability For An Affordable Housing In Malaysia*. Universiti Teknologi Malaysia, Skudai.